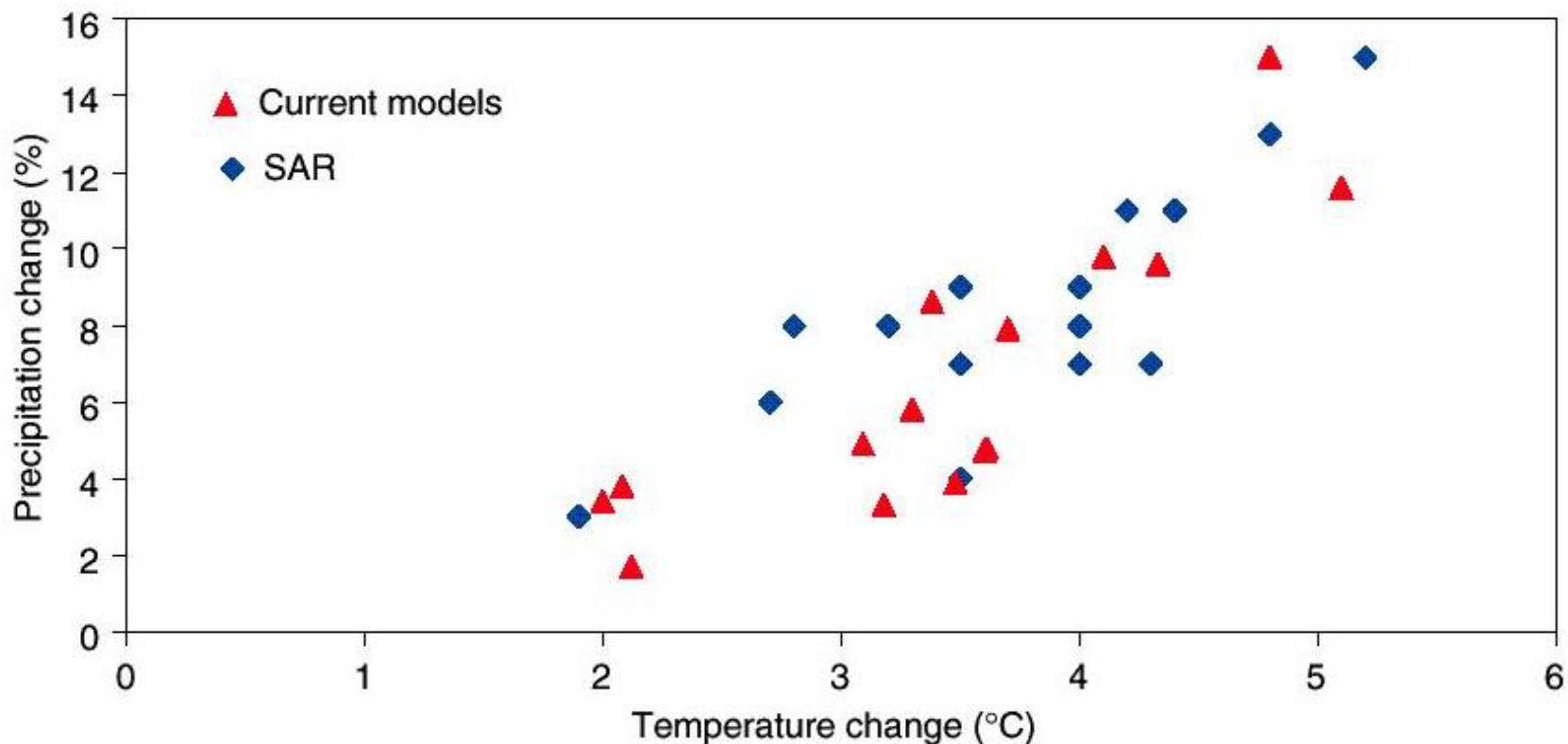


# International Cloud Feedback Model Intercomparison Project CFMIP

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Laboratoire de Météorologie Dynamique du CNRS  
France

# Climate sensitivity



# Cloud Feedback Model Intercomparison Project

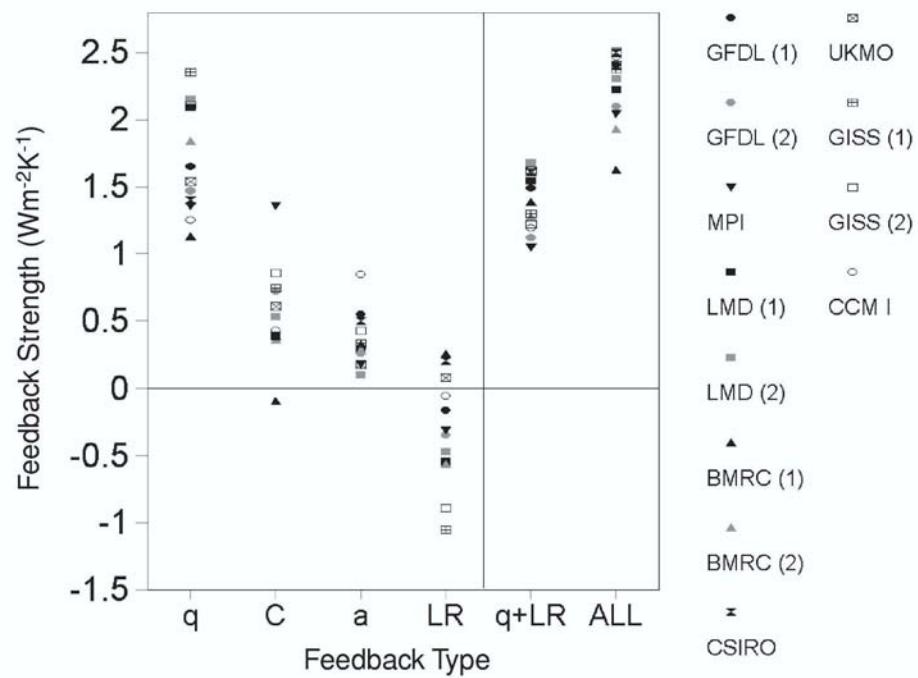
Convenors: McAvaney and Le Treut - WGCM

- Participation
  - BMRC
  - LMD
  - Hadley
  - MGO
  - MRI
  - GFDL
  - CSIRO
  - UIC
  - CSU
  - NCAR
  - GISS
  - ?

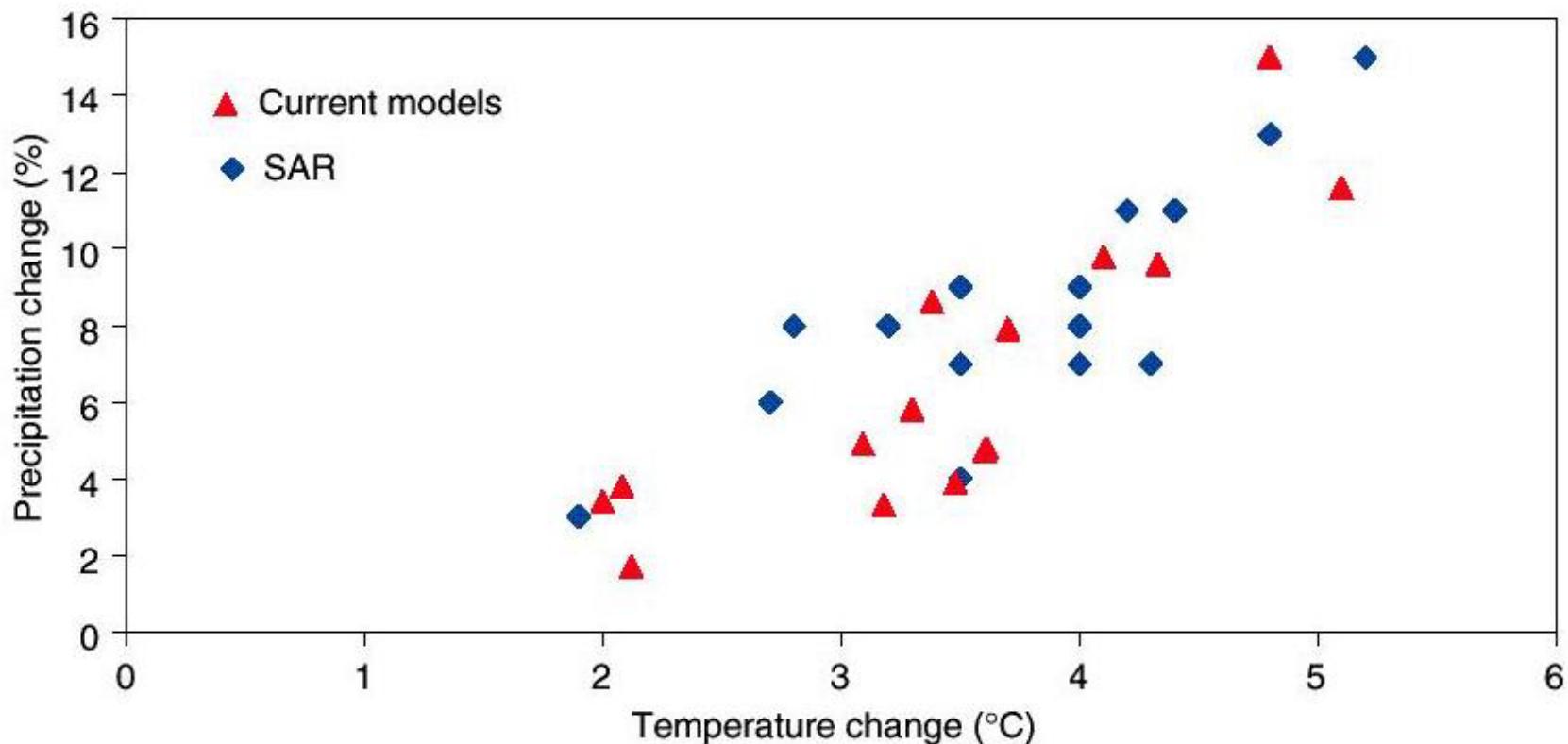
# Why Clouds ?

- Other feedbacks just as uncertain
  - Colman (2003)
    - Water vapour
    - Lapse rate
    - Albedo
- Cloud processes
- Framework envisages expansion

# Feedback Strengths



# Climate sensitivity



# Cloud Feedback Intercomparison: Aims

- Magnitude of Cloud Feedback
  - Components
  - Cloud Processes
  - Transition from FANGIO to SLOMs
- Clouds
  - ISCCP simulator
- Dynamical Regimes

# ISCCP Simulator

- Key ingredient to project
- Developed by Klein – Webb
- Based on ideas of Yu et al, 1996
- Code maintained freely available - vectorised

# Cloud Feedback Intercomparison: The Experiments – I: FANGIO

- FANGIO
  - SST Forced +2/-2 : AMIP2 mean SST
  - Fixed Season (July)
- Added
  - ISCCP Simulator “In Line”
  - AMIP 2 standard diagnostics
- Link to AMIP

# Cloud Feedback Intercomparison: The Experiments – II: SLOM

- Slab Ocean
  - AMIP Linked
- Standard AMIP 2 Diagnostics
- Add ISCCP Simulator
- Range of Diagnostic Experiments

# Cloud Feedback Intercomparison: SLOM Experiment

- Experimental Conditions
  - 50 m
  - Q-Flux (ocean and ice)
  - AMIP 2 conditions otherwise
  - Recommend “in-line” ISCCP simulator
  - AMIP 2 standard diagnostics

# Cloud Feedback Intercomparison: The Links

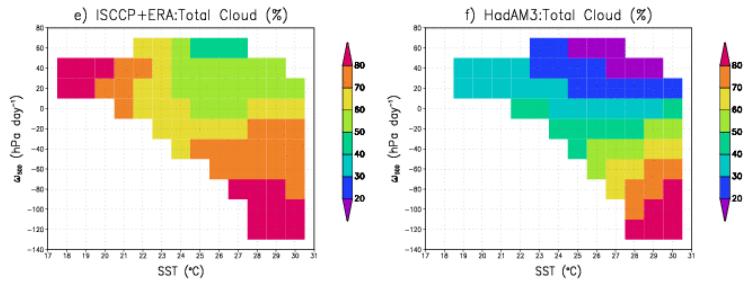
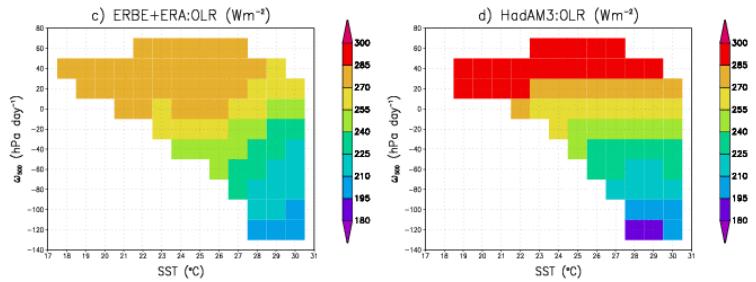
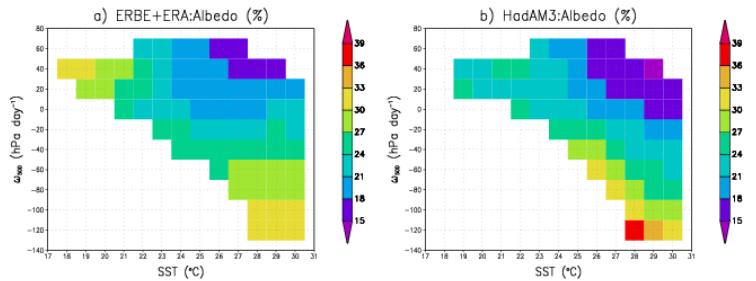
- AMIP 2
  - Cloud Diagnosis – especially use of IS
- ARM
  - Cloud Diagnosis : use of IS
- CMIP
  - Atmospheric Component
  - SLOM
- Other
  - National / European Plans

# Cloud Feedback Intercomparison: Diagnostic Sub Projects - 1

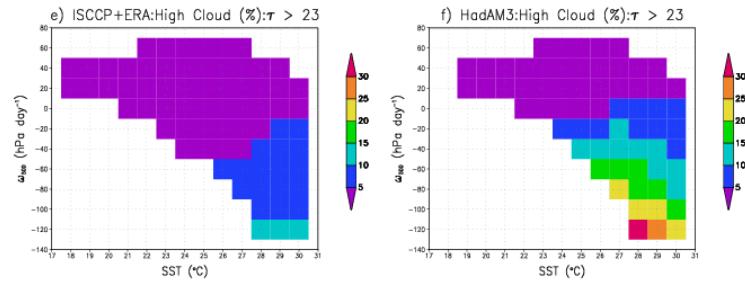
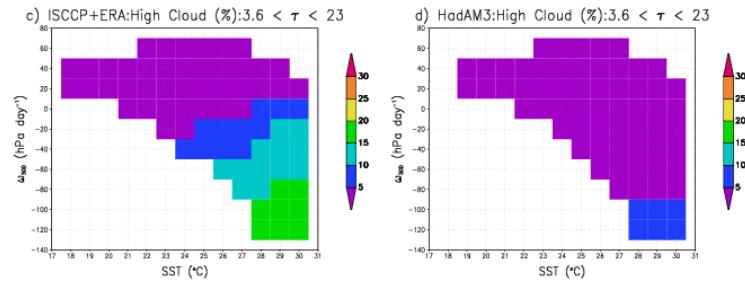
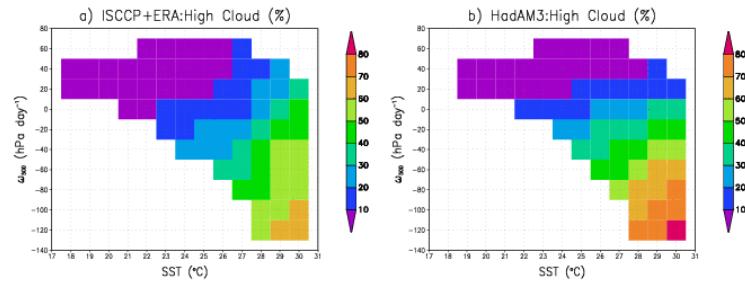
- Clouds in 0K FANGIO
  - IS
    - “Dynamic” and “thermodynamic” regimes
- Changes in Clouds - +2/-2K
- CRF
- CRF changes
- Surface Energy Budget Changes
- CO2 Forcing

# Dynamical Regimes Tropical: Current Climate

## Albedo OLR Total Cloud



## Cloud Types



# Dynamic and thermodynamic changes

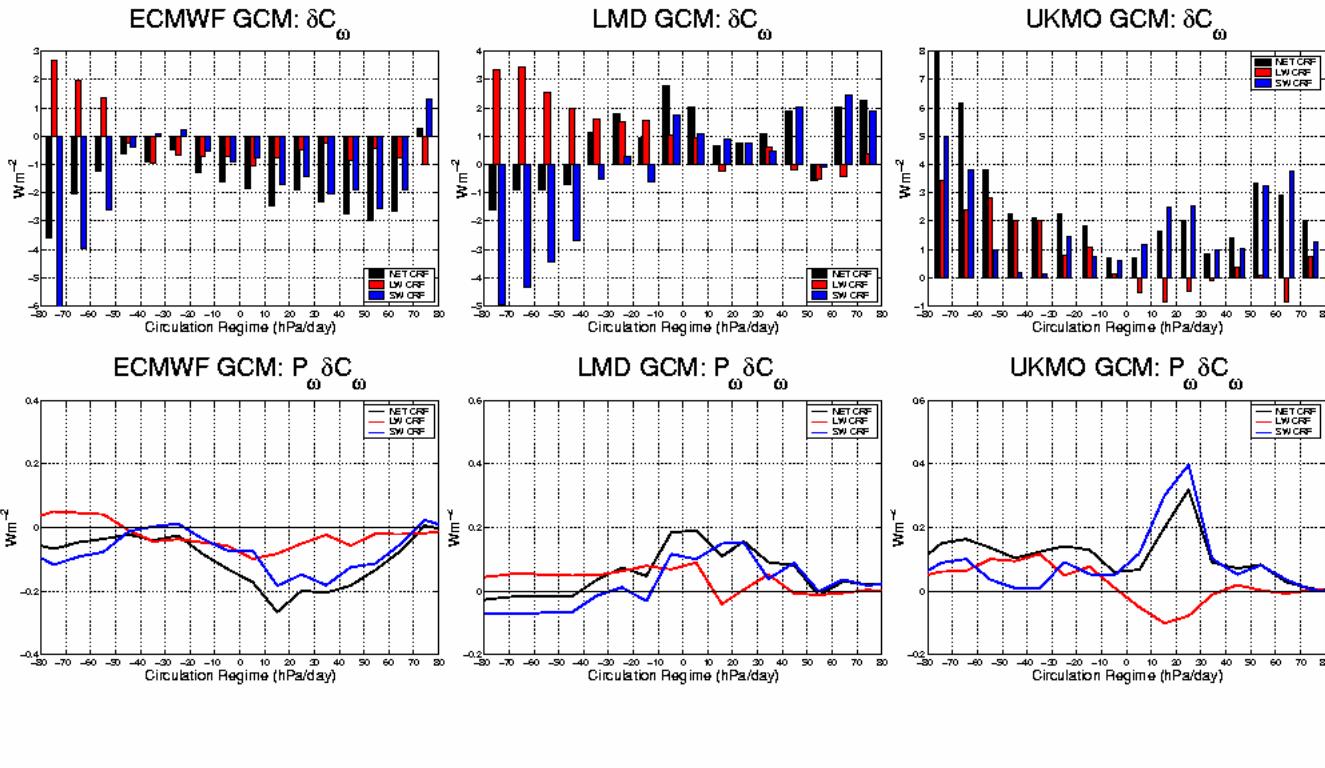
- New methodology to separate dynamic and thermodynamic components in tropics
  - Composite Clouds into vertical velocity bins – “ $\omega$  basis” and define averaging operator for each bin.

$$\delta C = \sum_{\omega} C_{\omega} \Delta P_{\omega} + \sum_{\omega} P_{\omega} \Delta C_{\omega} + \sum_{\omega} \Delta C_{\omega} \Delta P_{\omega}$$

Dynamic (changes in large scale circulation  $P_{\omega}$ )-  
thermodynamic (changes in  $C$  for given  $\omega$ ) –  
correlation of dynamic and non-dynamic effects

$P_{\omega}$  is (normalised)  
area of regions with  $\omega$

Figure 5: +2K-CTRL change in the LW, SW and NET cloud radiative forcing ( $\delta C_\omega$ ) in each dynamical regime of the Tropics, and effective contribution ( $P_\omega \delta C_\omega$ ) to the tropically-averaged change in cloud radiative forcing  $\overline{\delta C}$  (note that  $\int_{-\infty}^{+\infty} P_\omega \delta C_\omega d\omega$  equals the thermodynamic component of  $\overline{\delta C}$  reported in Table 2).



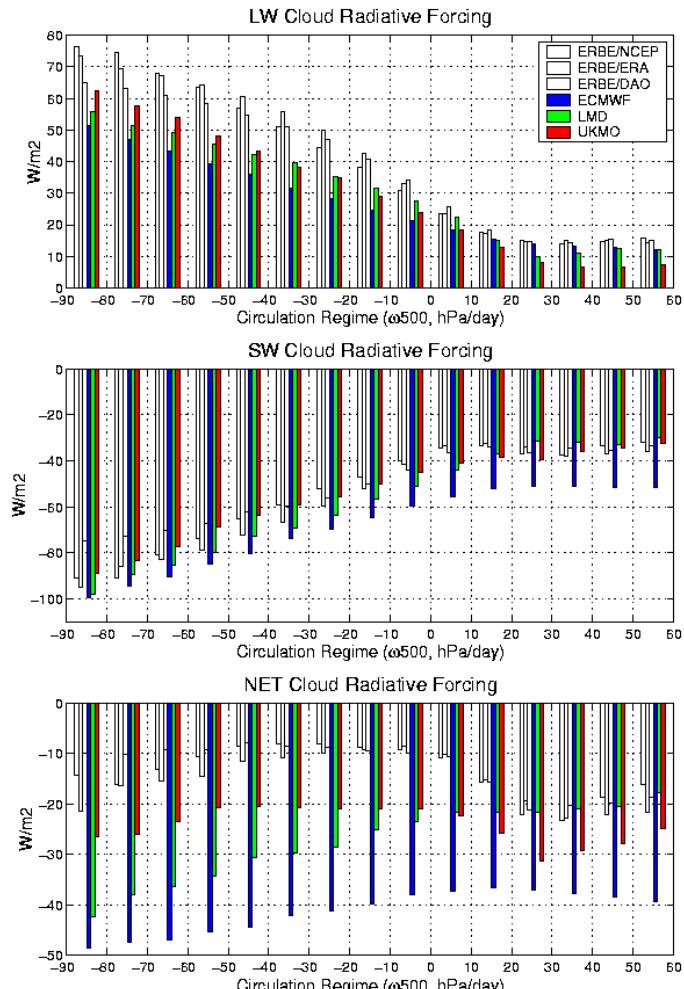


Figure 7: Composites  $C_\omega$  of the mean LW, SW and NET cloud radiative forcing in different dynamical regimes defined from the monthly mean 500 hPa vertical velocity. For each dynamical regime are reported the composites derived from GCM simulations (color bars) as well as composites derived from ERBE data for the cloud radiative forcing and different sets of atmospheric reanalyses for the 500 hPa vertical velocity (white bars, ERA, NCEP/NCAR

# Cloud Feedback Intercomparison: Diagnostic Sub Projects - 2

- Slab Ocean Model
  - “Standard” changes
  - Cloud Changes
  - IS Cloud Changes
    - Tropics
    - Mid Latitudes

# Cloud Feedback Intercomparison: Cloud changes Diagnostics

- Bin
  - 3 cloud top pressures (high, middle, low)
  - 3 visible optical thicknesses (thin medium thick)
  - Composite by 500hPa vertical velocity, static stability

# Dynamic Regimes: Mid Latitudes: 1\*CO<sub>2</sub> and 2\*CO<sub>2</sub>

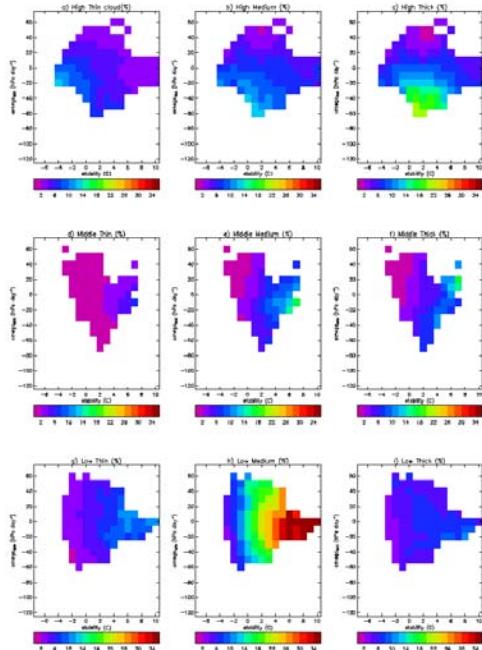


Figure 4: Monthly multi-annual mean cloud amount (%) over the mid-latitude oceans (30°N/S - 60°N/S), simulated in the HadSM4 1xCO<sub>2</sub> integration, composited by 500hPa vertical velocity and stability to a saturated air parcel.

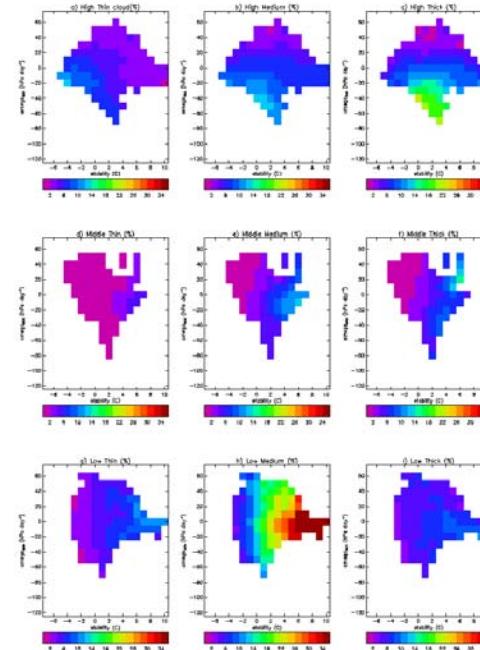


Figure 5: Monthly multi-annual mean cloud amount (%) over the mid-latitude oceans, simulated in the HadSM4 2xCO<sub>2</sub> integration, composited by 500hPa vertical velocity and stability to a saturated air parcel.

# Dynamic Regimes – Mid Latitudes Current HADSM3- ISCCP

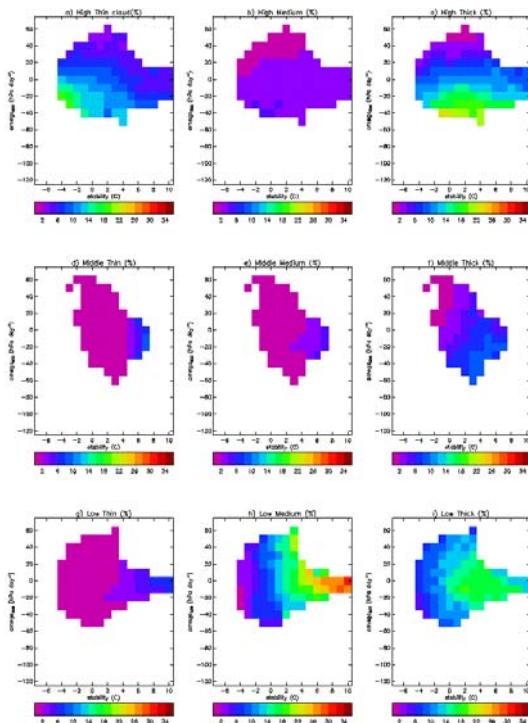


Figure 6: Monthly multi-annual mean cloud amount (%) over the mid-latitude oceans, simulated in the HadSM3 1xCO<sub>2</sub> integration, composited by 500hPa vertical velocity and stability to a saturated air parcel.

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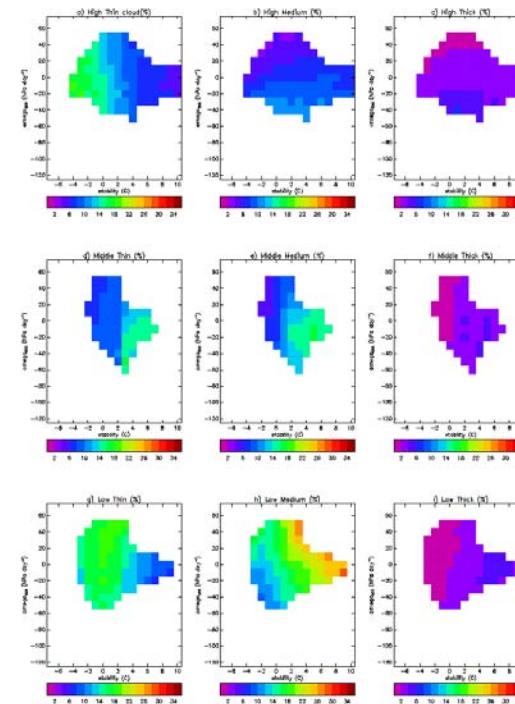


Figure 7: ISCCP observations of monthly cloud amount (%) over the mid-latitude oceans for the period March 1985–February 1990. The cloud amounts are composited by 500hPa vertical velocity and stability from ERA. The space populated is somewhat larger than for the model due to the different sampling. The data has, therefore, been masked to only show the region which both models populate.

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# Cloud Feedback Intercomparison: Cloud changes Diagnostics

- Regimes
  - Mean cloud amount varies little as CO<sub>2</sub> increases
  - Net change due to change in population
  - Mid latitudes – too much optically thick cloud too little of medium and thin cloud types

# Cloud Feedback Intercomparison: Diagnostic Sub Projects – 3

- Feedback analysis Techniques
  - “Classic” Feedback analysis
    - Radiative perturbation at TOA
    - Colman approach
  - Regional aspects
- Emerging “non linear” approaches
  - A data source

# Cloud Feedback Intercomparison: Timetable

- Climate Sensitivity Workshop
  - April 2004: Exeter
- IPCC – 4AR
  - Input
  - Scoping Meeting April 2003
- Timetable
  - FANGIO
    - Mid 2003 (some results – without IS !! – already in)
  - SLOM
    - Analysis commence Dec 2003 – Funding issues

# Data Management

- Continuing Problem
- Often Overlooked
  - netCDF/CF
- Distributed Data Handling
  - Desired for CFMIP
- WCRP “white paper”
- Data discovery

# Summary

- CFMIP
  - Two Experimental Protocols
    - FANGIO
    - SLOM
  - ISCCP Simulator Heavily Promoted
  - Diagnostic Sub-Projects
  - Link with AMIP/CMIP
- Funding is limiting participation